INTERCEPTOR TRENCH SYSTEM WATER BALANCE

Submitted to.
Solar Ponds Project Office
EG&G Rocky Flats Inc

Submitted by
Surface Water Division
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EXECUTIVE SUMMARY

This study utilizes existing precipitation data previously determined ground water flow estimates and a previously generated surface water runoff model to calculate the water balance for the Interceptor Trench System (ITS) The main components of the ITS examined for the flow calculations listed in this report are underground drain portion of the ITS that intercepts ground water the French drain that intercepts surface water runoff and the Interceptor Trench Pump House (ITPH) which pumps the water to the Temporary Modular Storage Tanks (TMST)

The calculated average ground water inflow to the ITS ranges from 50 000 to 120 000 gallons per month For precipitation events up to 1 5 in 2 hours the surface water runoff flow is dominated by contributions from the Building 779 area The 1 5 /2 hour storm event is comparable to the 5 year storm event at the Rocky Flats Plant (RFP) The hydrographs for storm events of 1 5 /2 hour or greater show significant attenuation of the storm water flows due to the flow limitation of the 15 corrugated metal pipe (CMP) that drains the Building 779 area The travel times of the surface runoff to the ITS are extremely short from the standpoint of the OU4 IM/IRA operations The surface runoff flow rate for the area tributary to the French drain is much greater than the maximum ITPH capacity (100 gpm) for all but the smallest RFP precipitation events Runoff modeling shows that for storm events of less than 0 25 /2 hours no appreciable runoff is generated for the tributary area

The contribution of the Building 779 area significantly increases the calculated total volume of inflow to the French drain and subsequently the TMST For average annual precipitation the calculated inflows to the French drain with and without the Building 779 drainage area are approximately 2 0 million gallons and 1 3 million gallons respectively For an average precipitation year the calculated reduction of the total inflow to the TMST by removing the flow from the Building 779 area is 36% (700 000 gallons) Removing the flow from the Building 779 area results in calculated reductions of inflow for maximum annual and maximum monthly precipitation by 45% (1 1 million gallons) and 56% (2 3 million gallons) respectively A determination should be made regarding the validity of the inclusion of the Building 779 area surface water runoff in the OU4 IM/IRA

The runoff and ground water flow volumes contained in this report are based on limited data and have been determined using validated models which provide reasonable estimates for design purposes These models are not a substitute for accurately collected field data The collection of accurate site specific data is also necessary to refine and calibrate the precipitation TMST inflow relationship estimated in this report An example of a minimum site specific data collection system would include (1) a tipping bucket rainfall gauge (2) flow monitoring equipment on the TMST inflow and (3) flow monitoring of any ITPH overflows

PRECIPITATION DATA

The precipitation data used in this report has been supplied by the EG&G Air Quality Division Tabular and graphical precipitation data are listed below

TABLE 1 Normal (1961 1990) and Extreme (1953 1993)
Monthly Precipitation at the Rocky Flats Plant (in inches)

Month	Mean	Maximum Monthly	Year	Maximum Annual (listed monthly)	Year
January	0 46	1 73	1959	0 25	1969
February	0 53	1 81	1959	0 12	1969
March	1 24	4 52	1983	0 79	1969
April	1 75	4 73	1973	1 02	1969
May	2 74	9 70	1969	9 70	1969
June	2 05	4 79	1969	4 79	1969
July	1 64	5 10	1965	2 22	1969
August	1 57	4 59	1982	0 49	1969
September	1 46	4 49	1976	0 11	1969
October	0 91	4 83	1969	4 83	1969
November	0 80	2 47	1983	0 81	1969
December	0 54	1 50	1958	0 54	1969
TOTAL	15 69			25 67	

FIGURE 1 Interceptor Trench System Water Balance (4/13/93) Normal RFP Monthly Precipitation (1961 1990 Mean)

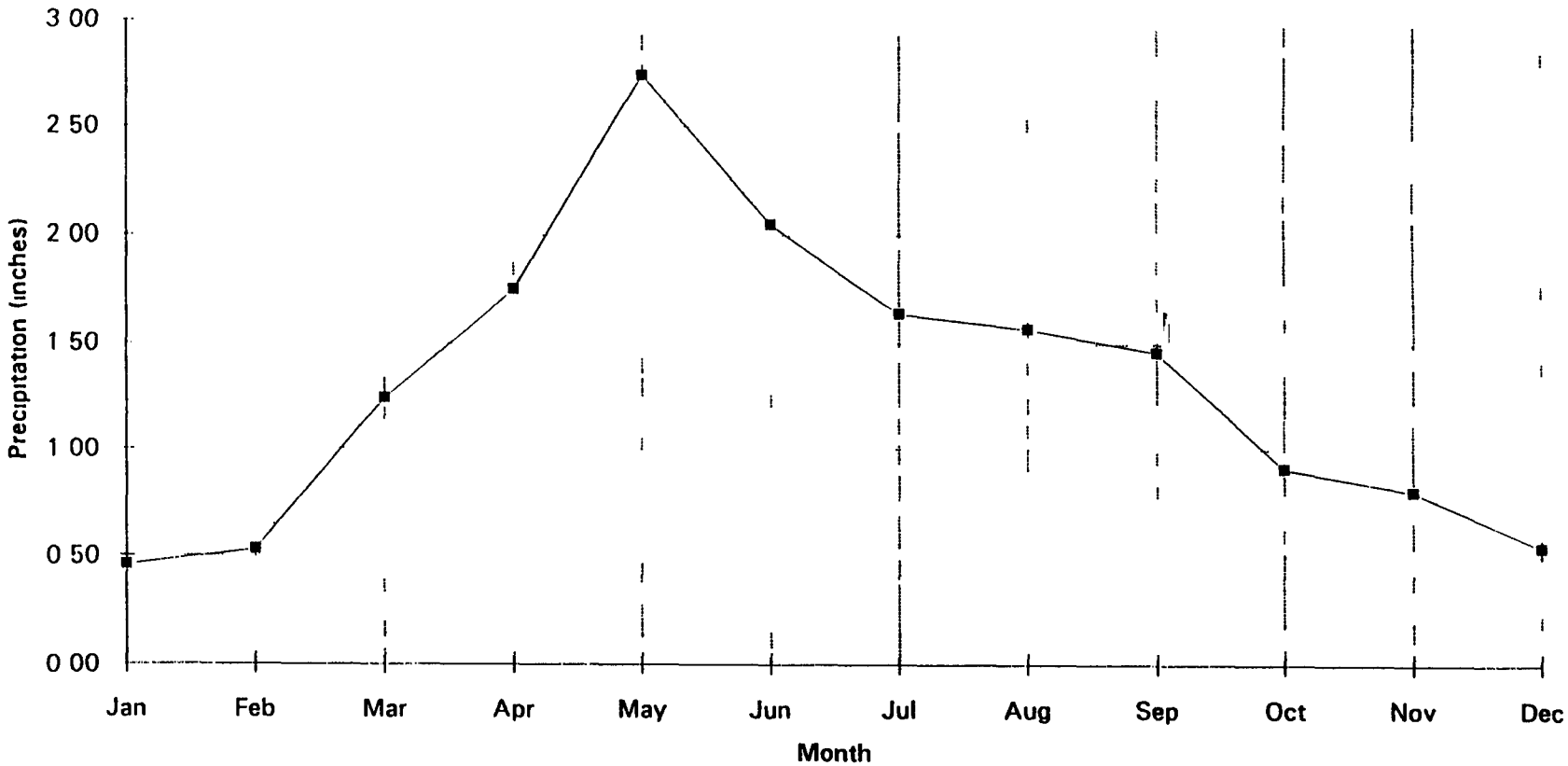
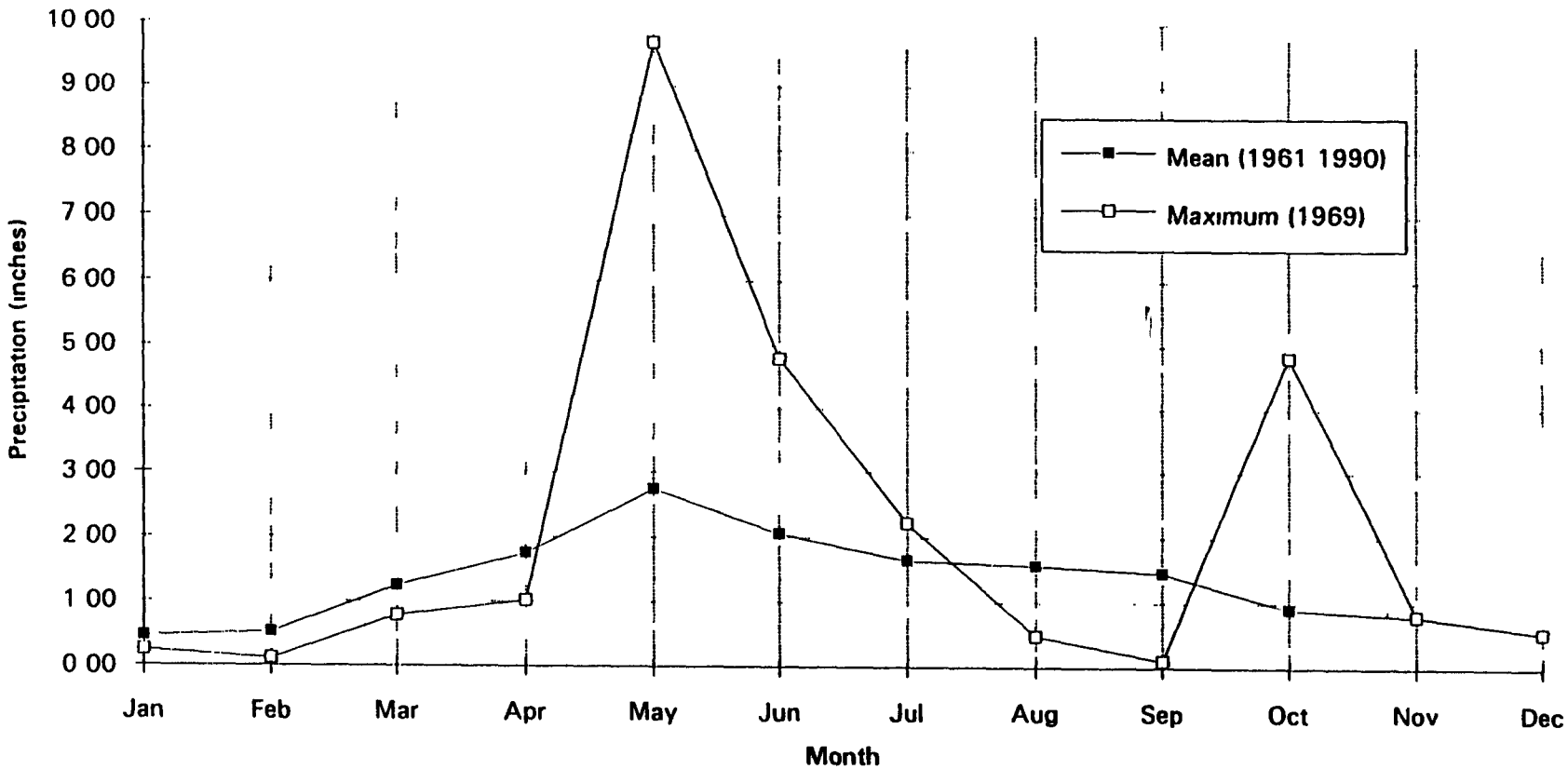


FIGURE 2 Interceptor Trench System Water Balance (4/13/93) Mean and Maximum Annual RFP Precipitation Listed Monthly



GROUND WATER

Ground water inflow into the Interceptor Trench System (ITS) has been calculated using the estimated average annual ground water inflow from the Task 7 Report of the Zero Offsite Water Discharge Study (EG&G 1991) This report estimated the average ground water inflow at 2 gallons per minute (gpm) which results in a ground water inflow of approximately 1 051 000 gallons per year

At RFP it has been observed that alluvial ground water flows vary seasonally For this report the Zero Discharge Study estimate of the annual ground water inflow has been proportioned according to the saturated thickness of the alluvium in the Solar Pond area Wells 2886 and 3787 which are located directly east of Solar Ponds 207 B North and 207 B South respectively were used to determine the average saturated thickness of the alluvium Flow rates were proportioned per Darcy s law as shown below

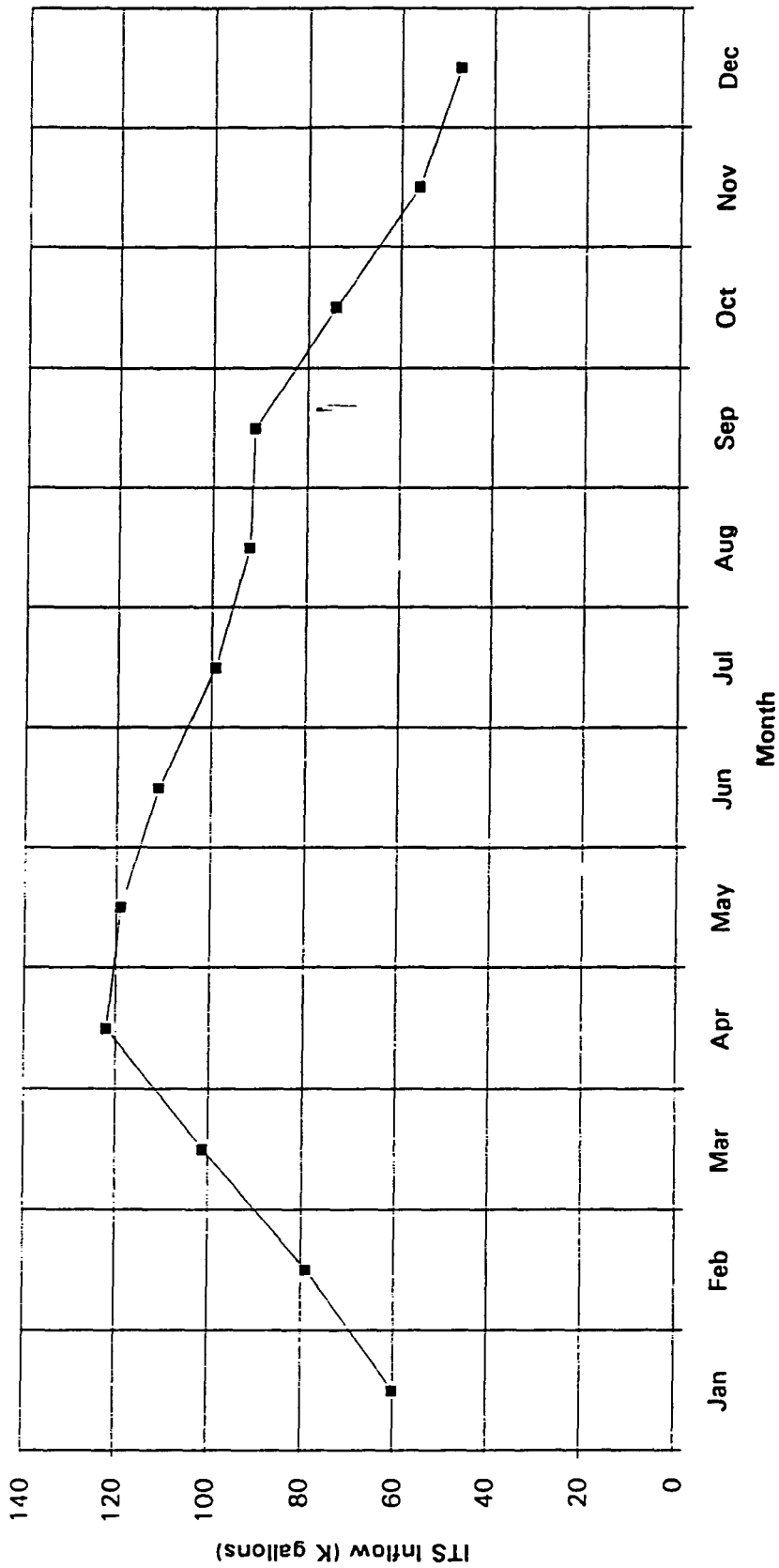
$Q = KIA$ Q = discharge
K = hydraulic conductivity (assumed to be constant)
I = hydraulic gradient (assumed to be constant)
A = cross sectional area (varies with saturated thickness)

Calculated average monthly ground water inflows are presented below in tabular and graphical formats

TABLE 2 Average Monthly ITS Ground Water Inflow

Month	Ground Water Inflow (K gallons)
January	60
February	79
March	101
April	122
May	119
June	111
July	99
August	92
September	91
October	74
November	56
December	47
TOTAL	1051

FIGURE 3 Interceptor Trench System Water Balance (4/13/93) Calculated Average Monthly ITS Ground Water Inflow



SURFACE WATER

The surface water contribution of the ITS inflow is directly related to the rainfall runoff relationship of the area tributary to the French drain that intersects the ground surface This French drain is located directly adjacent to the road north of the solar ponds

The areas that are tributary to the French drain include the hillside between the solar ponds and the French drain and the Building 779 area The surface water from the Building 779 area is routed through a 15 corrugated metal pipe (CMP) that outfalls on the aforementioned hillside It is unclear if the Operable Unit 4 (OU4) Interim Measure / Interim Remedial Action (IM/IRA) is intended to collect this Building 779 runoff However due to the present CMP configuration this runoff does contribute to the ITS inflow

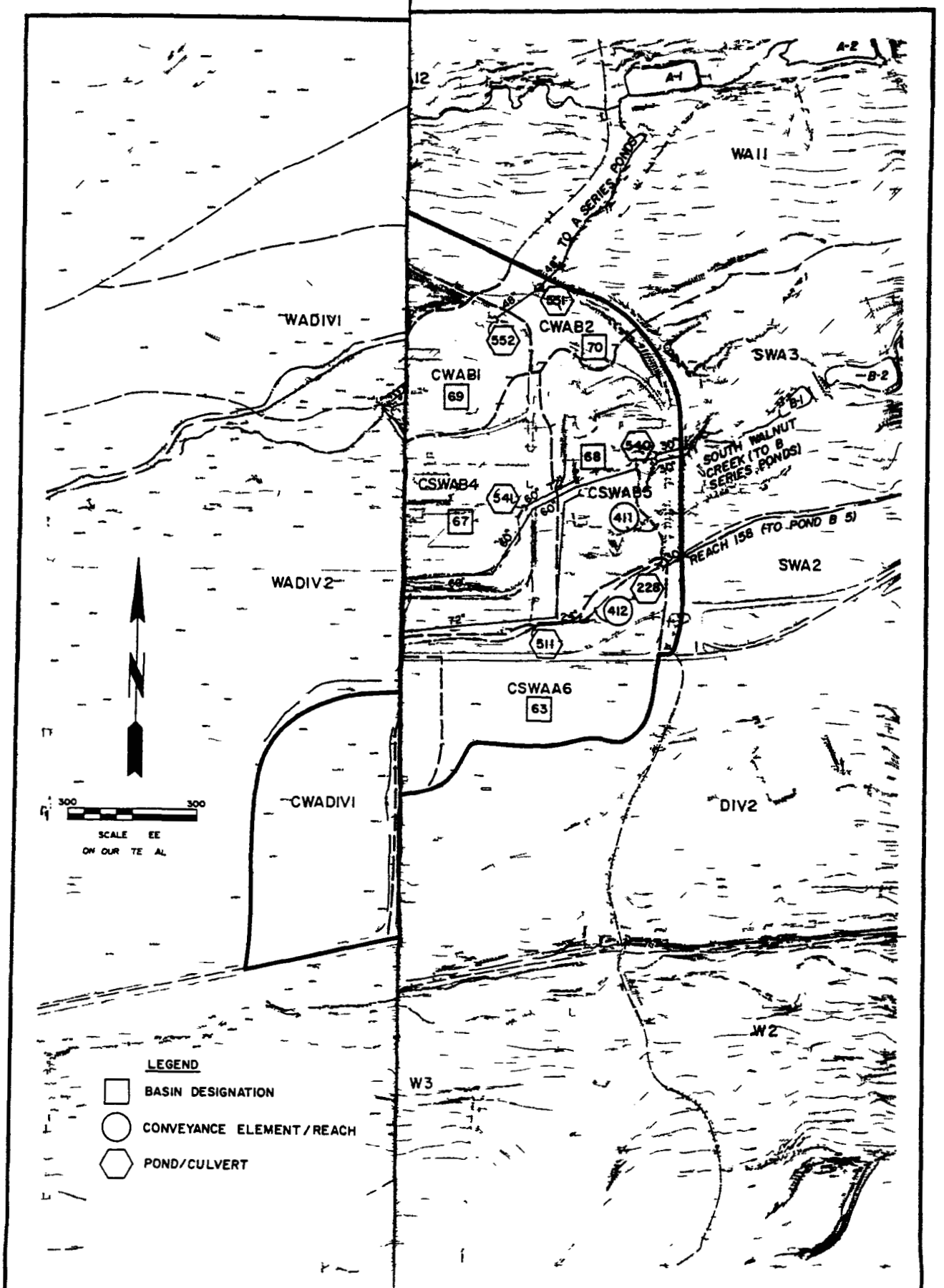
The rainfall runoff relationships for the ITS were determined using the model developed as part of the Rocky Flats Plant Drainage and Flood Control Master Plan (RFP MDP) (EG&G 1992) Specifically basins CWAC7 (hillside) and CWAC9 (Building 779 area) as shown on the attached Core Area Drainage Basin Map were included in the determination of the rainfall runoff relationships Basin parameters from the RFP MDP were slightly modified for use in determining runoff relationships for this study These modifications reflect the primary routing of the surface runoff into the French drain instead of the storm water drain and the reduction of the Bldg 779 area tributary to the 15 CMP as determined by field observations The modified basin parameters are listed below

TABLE 3 Basin Parameters

Basin ID	Area (sq miles) (acres)	Impervious Area (%)	Time of Concentration (minutes)	Initial and Final Infiltration Rate (inches/hour)
CWAC7 Hillside	0 013 8 3	10	6	0 50
CWAC9 Bldg 779	0 009 5 8	90	10	0 50

Runoff hydrographs for precipitation depths from 0 5 to 3 5 for 2 hour storm events are shown in Figures 4 through 11 The storm specific runoff hydrographs are shown for each basin individually and for both basins combined

For precipitation events up to 1 5 /2 hours the runoff flow is dominated by contributions from the Building 779 area The 1 5 /2 hour storm event is comparable



AREA DRAINAGE BASIN MAP

FIGURE 4 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPH
0 5 2 HOUR STORM EVENT

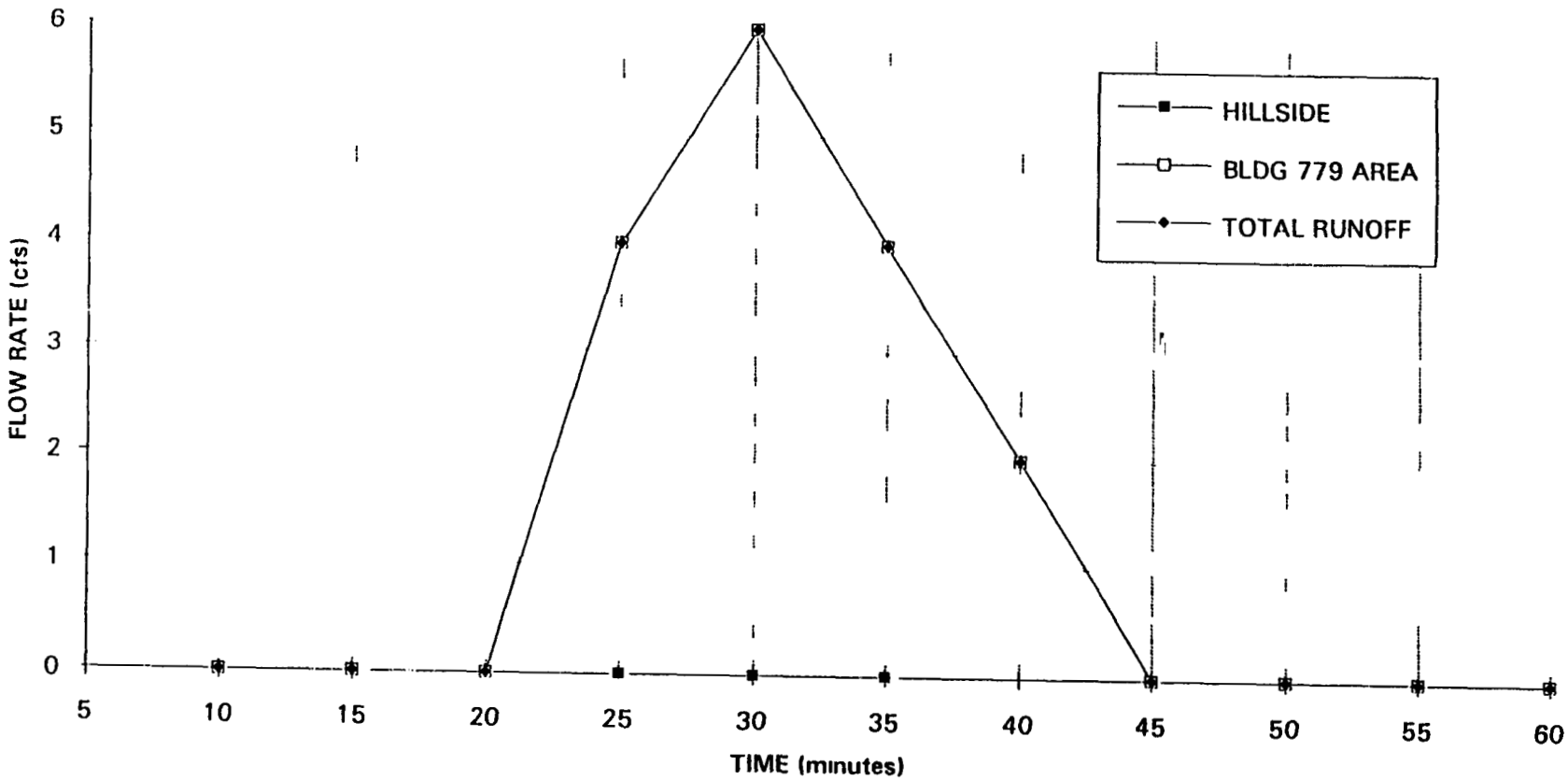


FIGURE 5 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPH
1 2 HOUR STORM EVENT

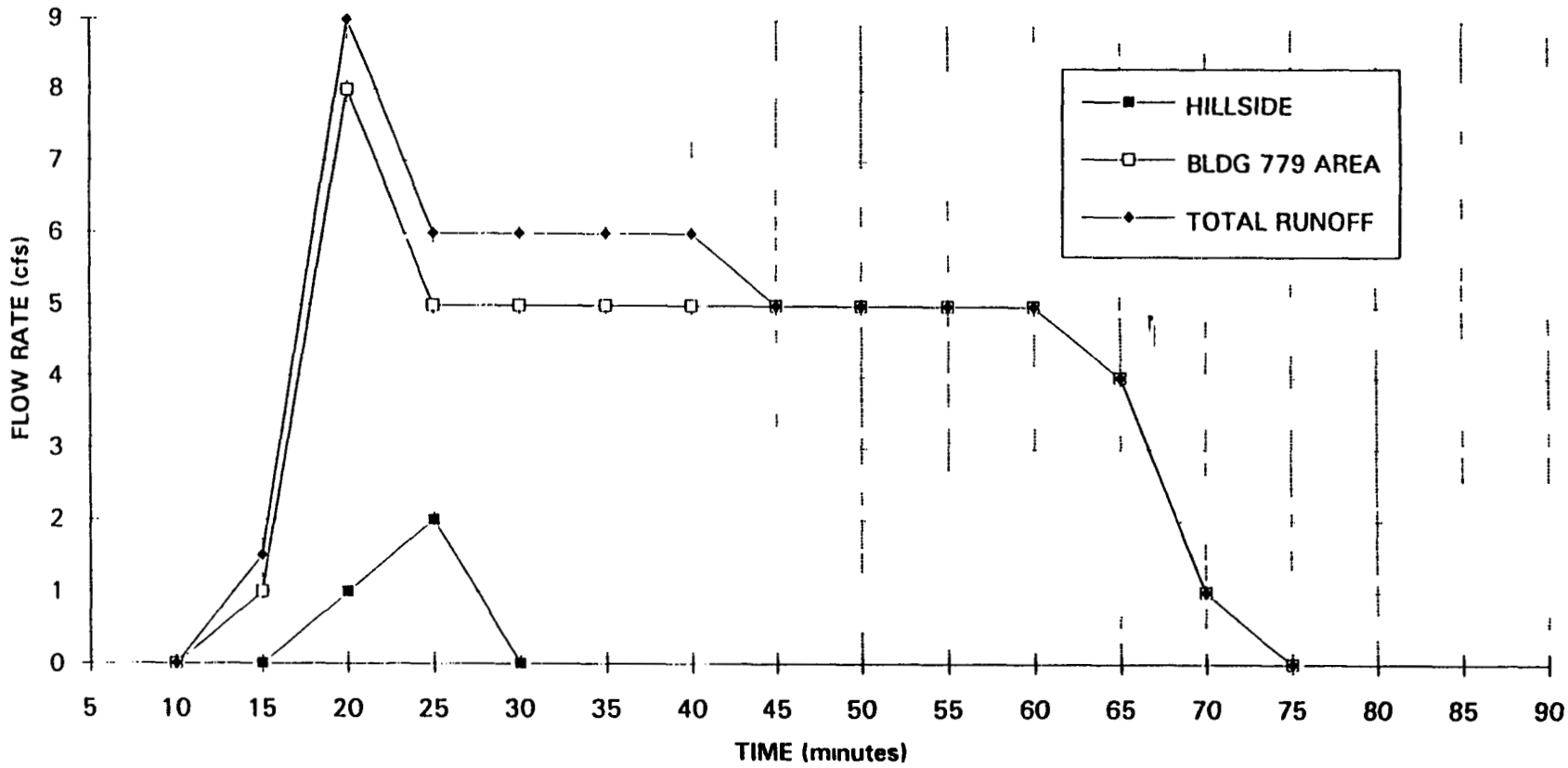


FIGURE 6 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPH
1 5 2 HOUR STORM EVENT

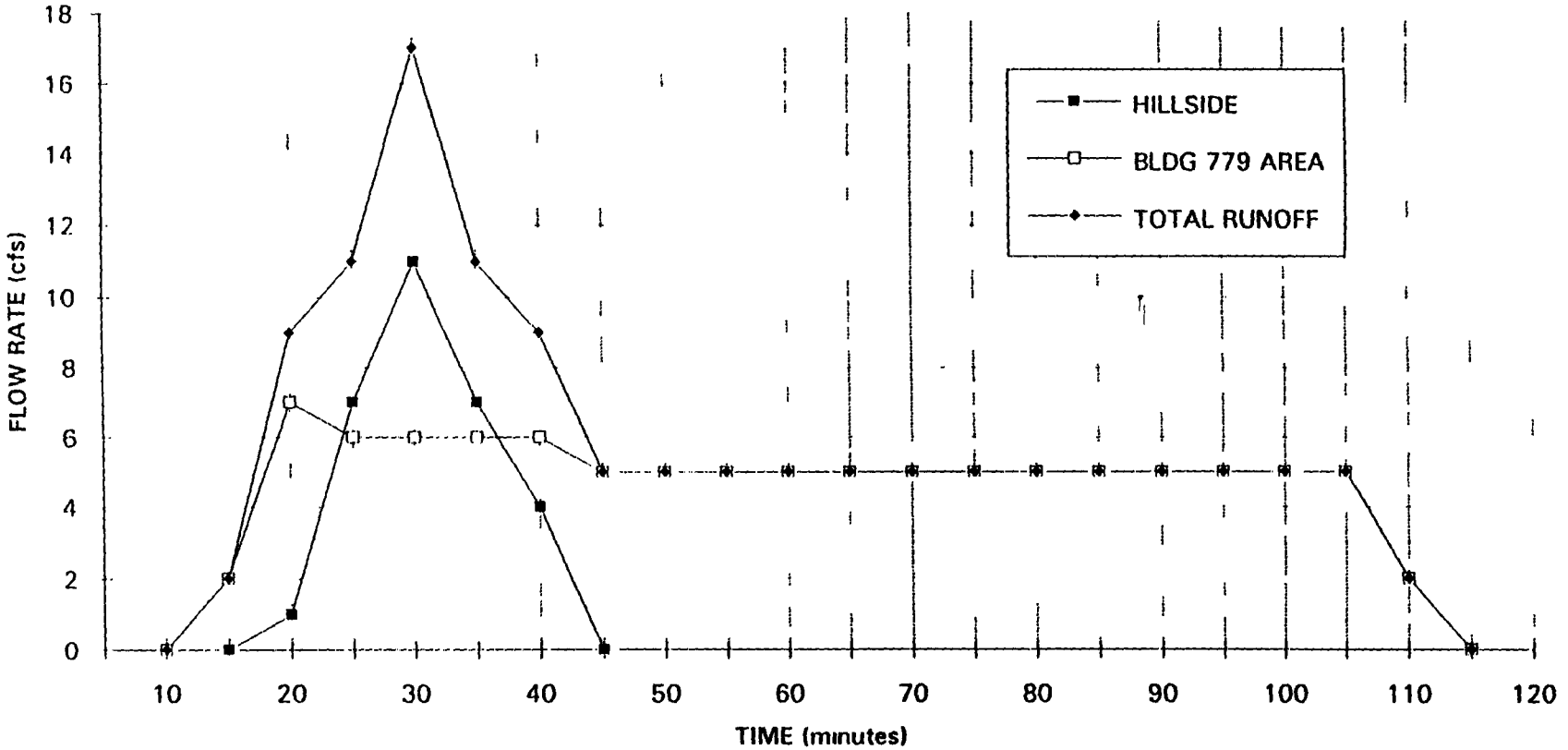


FIGURE 7 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPH
2 2 HOUR STORM EVENT

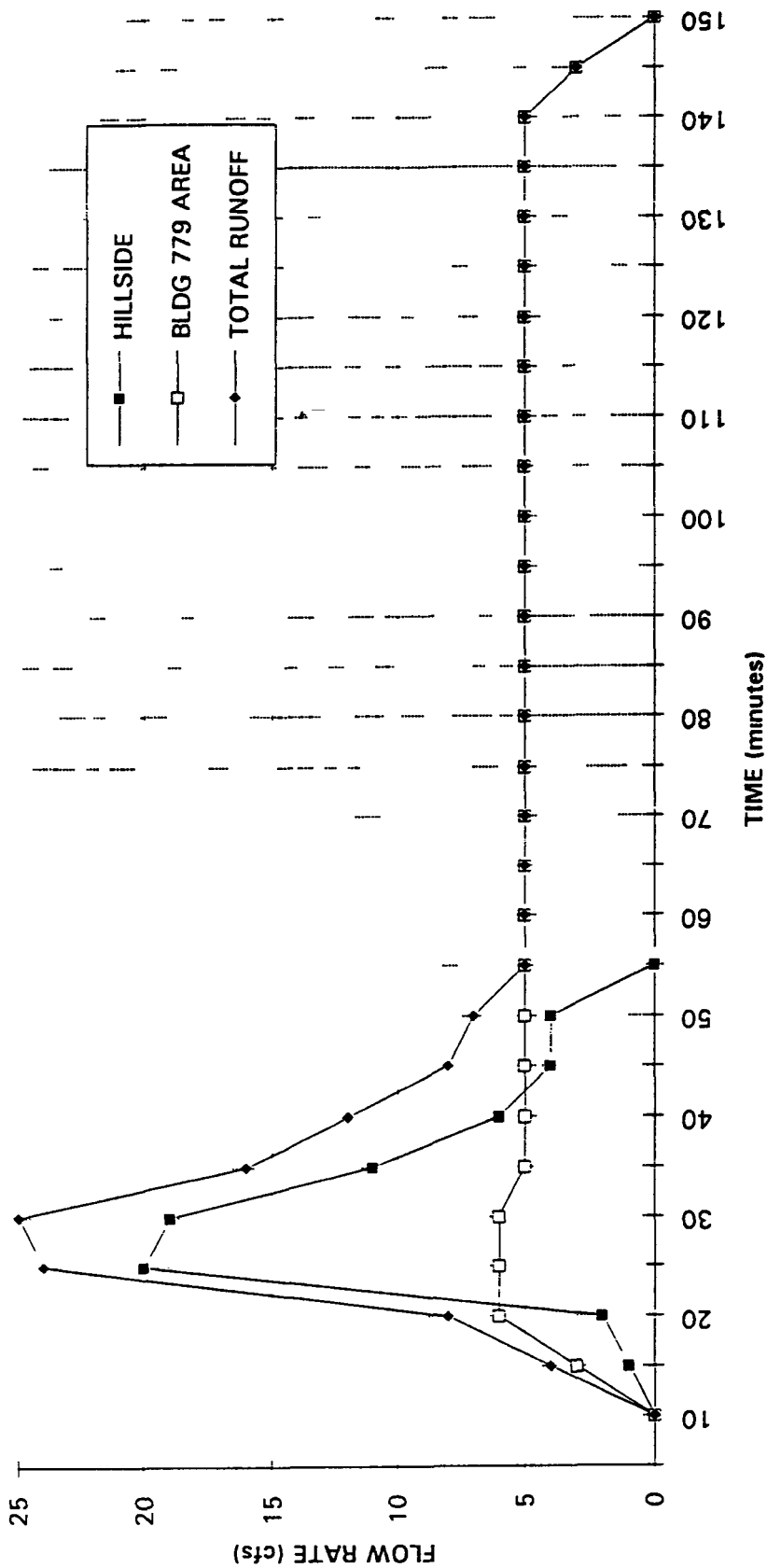


FIGURE 8 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPH
2 5 2 HOUR STORM EVENT

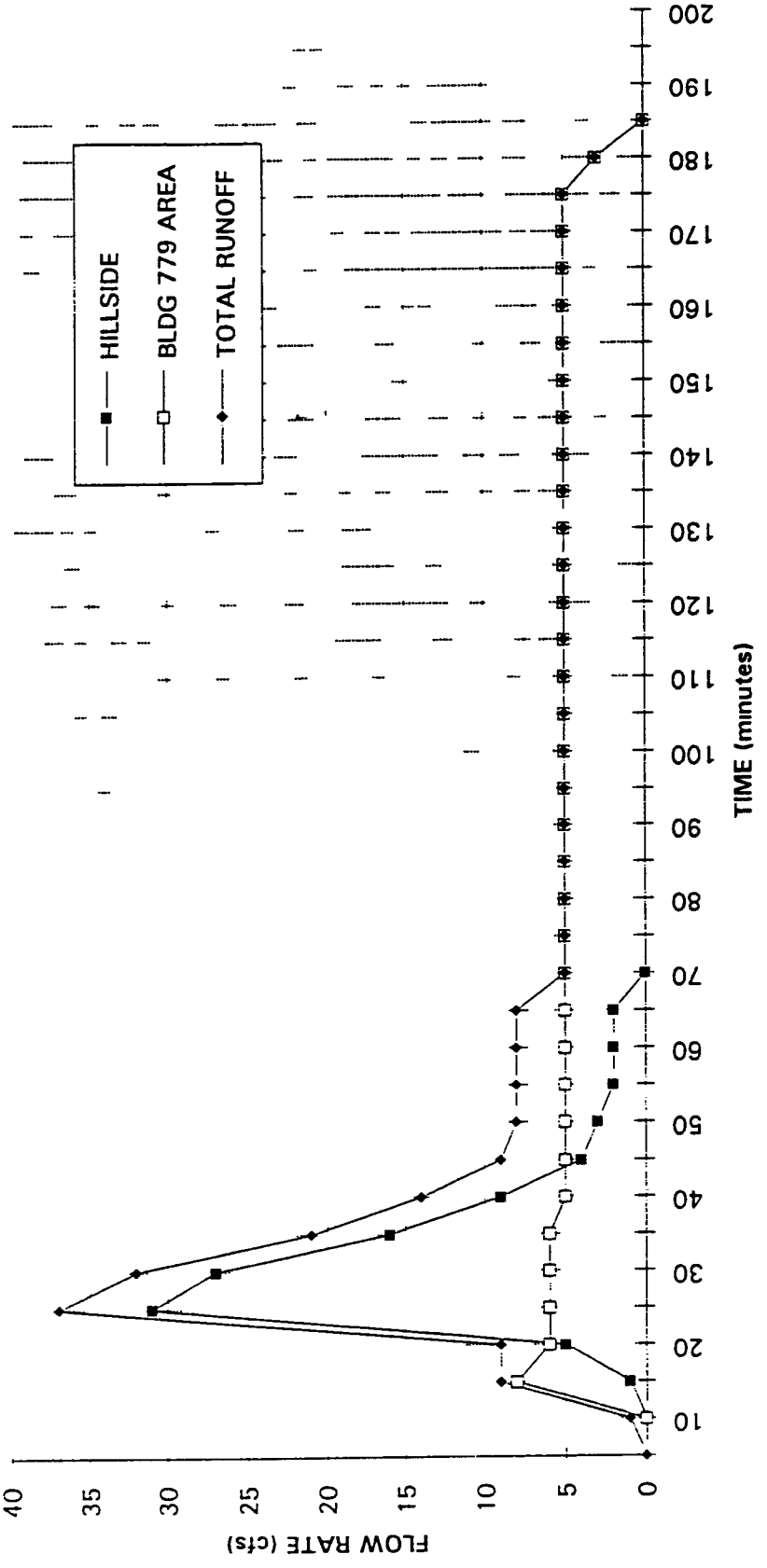


FIGURE 9 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPH
3 2 HOUR STORM EVENT

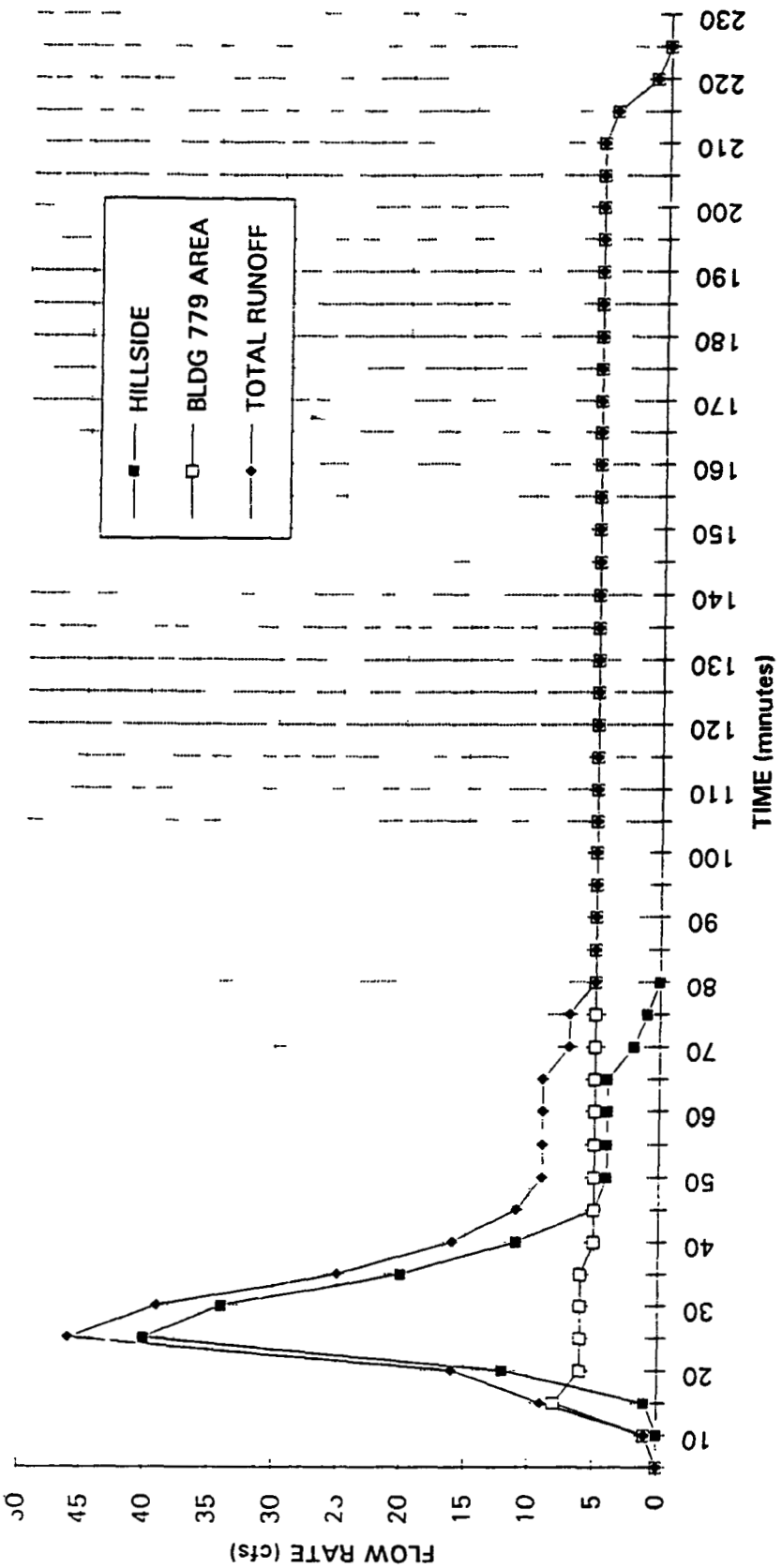


FIGURE 10 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPH
3 5 2 HOUR STORM EVENT

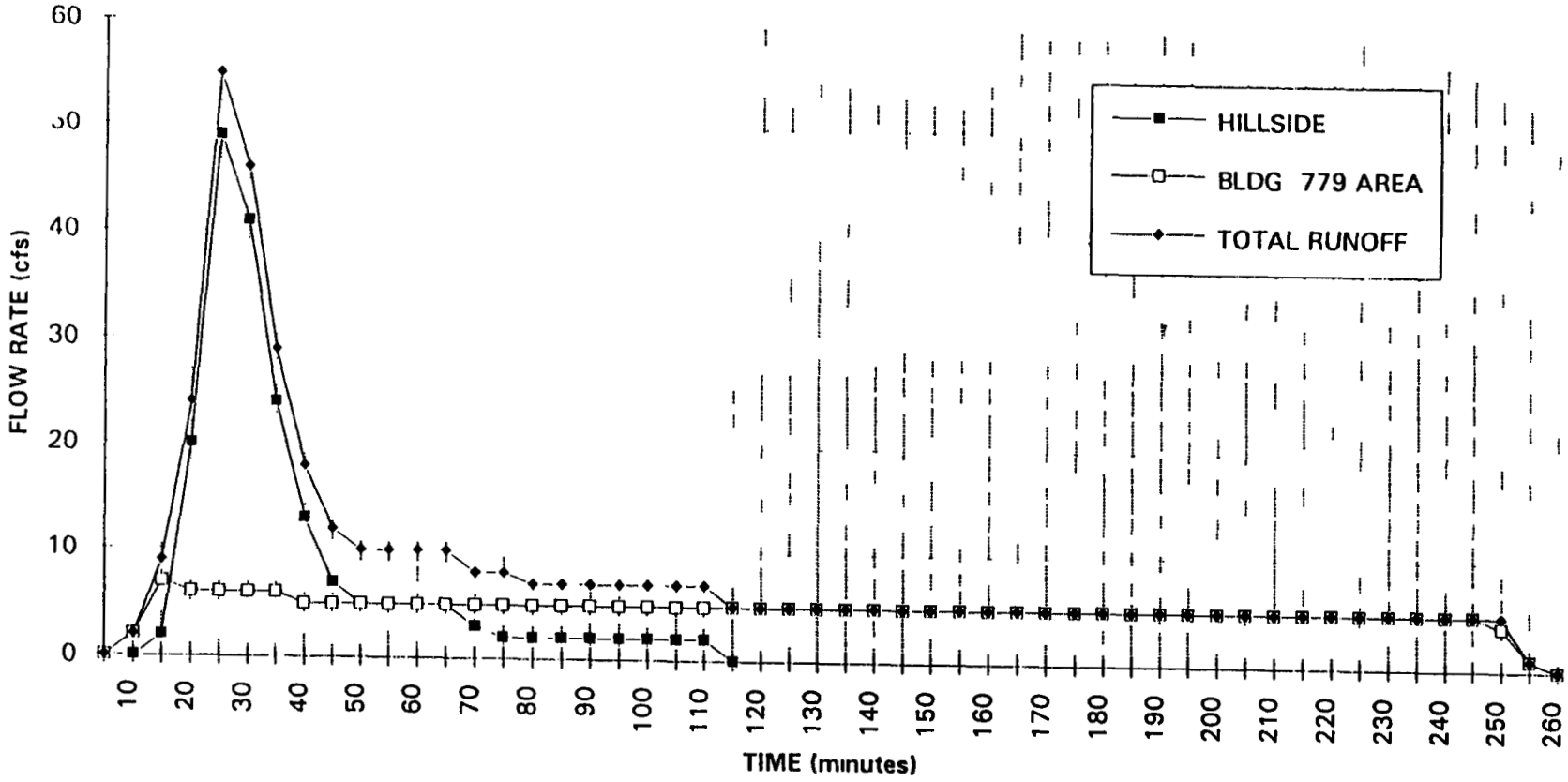
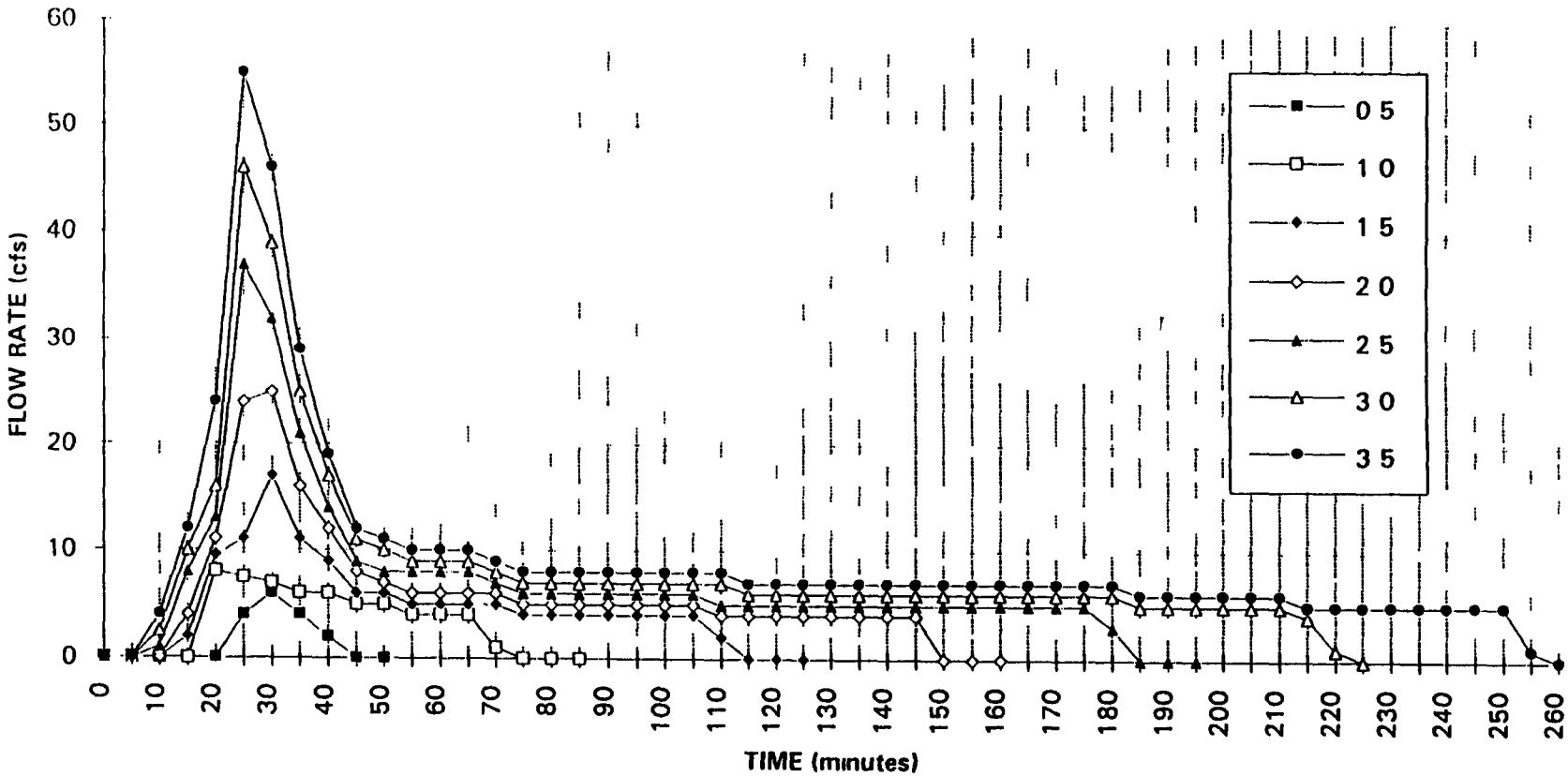


FIGURE 11 Interceptor Trench System Water Balance (4/13/93) RUNOFF HYDROGRAPHS FOR LISTED PRECIPITATION AMOUNTS (2 HOUR STORM DURATION)



to the 5 year storm event at RFP (EG&G 1992) The hydrographs for storm events of 1 5 /2 hour or greater show significant attenuation of the storm water flows due to the flow limitation of the 15 CMP that drains the Building 779 area

The travel times of the runoff to the French drain are extremely short from the standpoint of the OU4 IM/IRA operations (less that 4 5 hours for even the 3 5 /2 hour storm) For operational purposes there is no appreciable lag between a precipitation event (or snow melt) and the beginning of inflow to the TMST

INTERCEPTOR TRENCH SYSTEM (ITS) CONFIGURATION

The existing ITS configuration is such that the rate of the generation surface water runoff greatly exceeds the ITS intake capacity The configuration of the French drain portion of the ITS that intercepts the surface runoff is shown on RFP drawings 26637 01 and 26637 02 These drawings show that the French drain has a depth of 5 a width of 1 an approximate length of 1500 and is backfilled with gravel and drained by a single 4 PVC pipe The French drain slopes from both ends toward the center to a manhole This manhole is drained by another 4 PVC pipe that transports the water to the Interceptor Trench Pump House (ITPH)

The maximum flow rate of this piping configuration has been calculated to be approximately 200 gpm This flow rate has been determined using the following assumptions the pipe section from the manhole to the ITPH controls the flow is approximately 600 in length and has a 2% slope These assumptions were necessary due to the lack of engineering data regarding the existing configuration of the piping from the French drain to the ITPH Information supplied by the Solar Ponds Project Office (SPPO) states that the assumed pumping rate from the ITPH is 100 gpm The maximum water storage volume of the French drain is approximately 20 000 gallons assuming a porosity of 35% for the gravel

CALCULATION OF THE ITS INFLOW TO THE TEMPORARY MODULAR STORAGE TANKS (TMST)

The determination of the inflow to the TMST is controlled by several factors each of which singly may control the amount of inflow The most significant factors controlling the inflow to the TMST are

(1) Ground Water Flow
(2) Surface Runoff Flow from Precipitation Events
(3) Storage Volume of the French Drain
(4) Piping Configuration of the ITS
(5) Pump Capacity of the ITPH

Many simplifying but reasonable assumptions and inferences are necessary to calculate the inflow to the TMST These include

(1) The ground water flow rates estimated is the Task 7 Zero Discharge Report (EG&G 1991) are accurate
(2) The ground water flow rate is proportional to saturated thickness
(3) The French drain gravel is freely and instantaneously draining
(4) The pipe from the French drain manhole to the ITPH controls the flow rate from the French drain to the ITPH
(5) The first 20 000 gallons from a surface water runoff event is completely intercepted by the French drain
(6) After the first 20 000 gallons from a surface water runoff event surface water can only be allowed to enter the French drain at the calculated maximum French drain discharge rate (200 gpm)
(7) The travel time from the French drain to the ITPH is negligible which means that the duration of the inflow to the ITPH from surface runoff equals the duration of the surface runoff
(8) Flows in excess of the pumping capacity of the ITPH (100 gpm) overflow at the ITPH and become surface flow that is intercepted by the A Series ponds

Existing Tributary Area (Hillside and Building 779)

The ground water inflow rates are assumed to be relatively constant when considered for monthly inflows to the ITS These inflow rates are shown on Table 2 and Figure 3

The surface runoff flow rate for the area tributary to the French drain is much greater than the maximum ITPH capacity (100 gpm) for all but the smallest precipitation events Therefore during storm events of greater than 0 5 /2 hours most of the surface runoff bypasses the French drain Runoff modeling shows that for storm events of less than 0 25 /2 hours no appreciable runoff is generated for the tributary area The greatest amount of TMST inflow per inch of precipitation occurs during the 0 35 /2 hours storm event This storm event results in 18 000 gallons of runoff which equals 60 000 gallons of TMST inflow per inch of precipitation

Estimates of the maximum surface water runoff were calculated using the conservative value of 60 000 gallons of TMST inflow per inch of total precipitation The estimates are shown in Figures 12 13 and 14 and Tables 4 5 and 6

FIGURE 12 Interceptor Trench System Water Balance (4/13/93) TOTAL TMST INFLOW MEAN ANNUAL PRECIPITATION

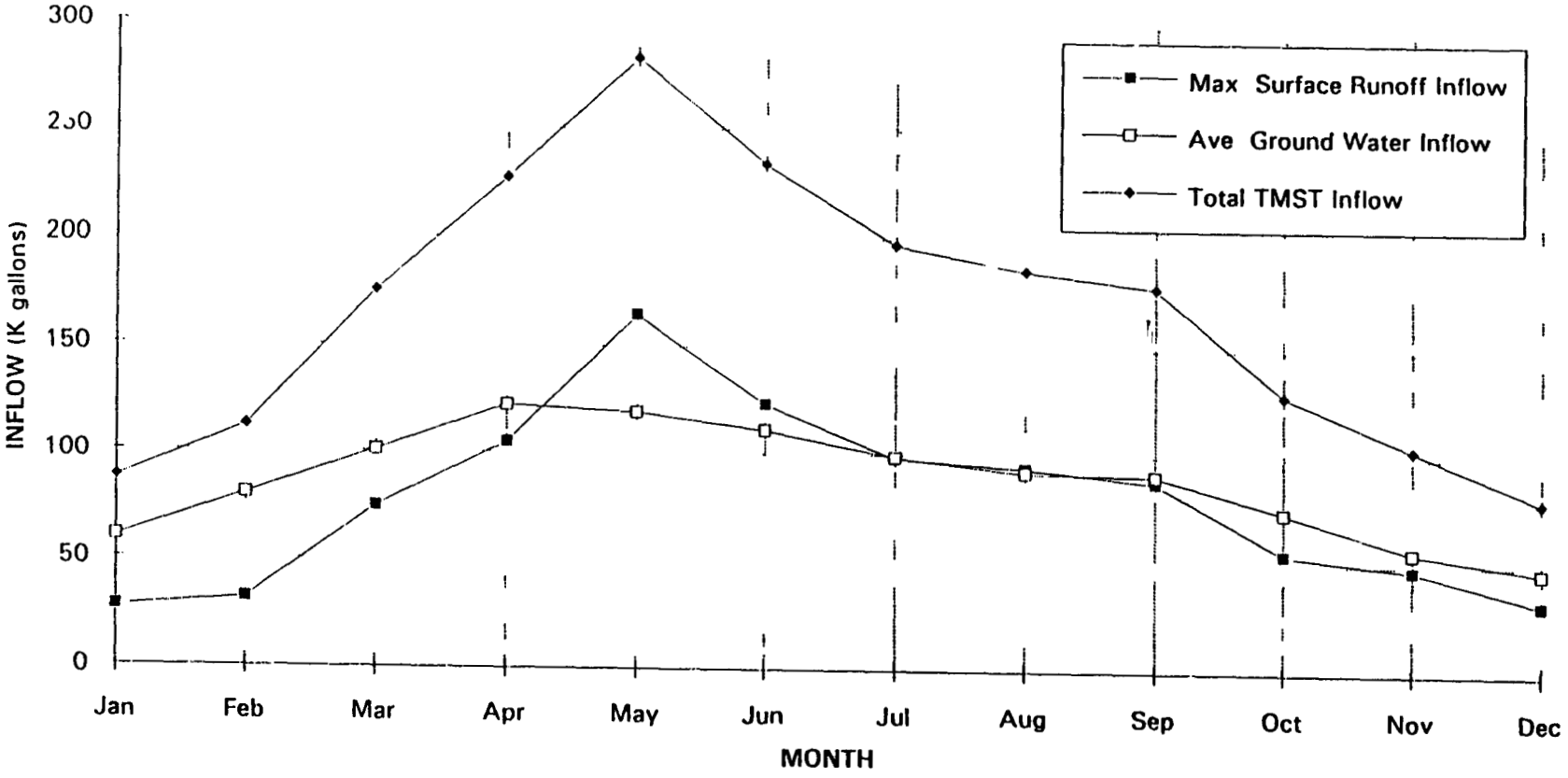


FIGURE 13 Interceptor Trench System Water Balance (4/13/93) TOTAL TMST INFLOW MAXIMUM ANNUAL PRECIPITATION

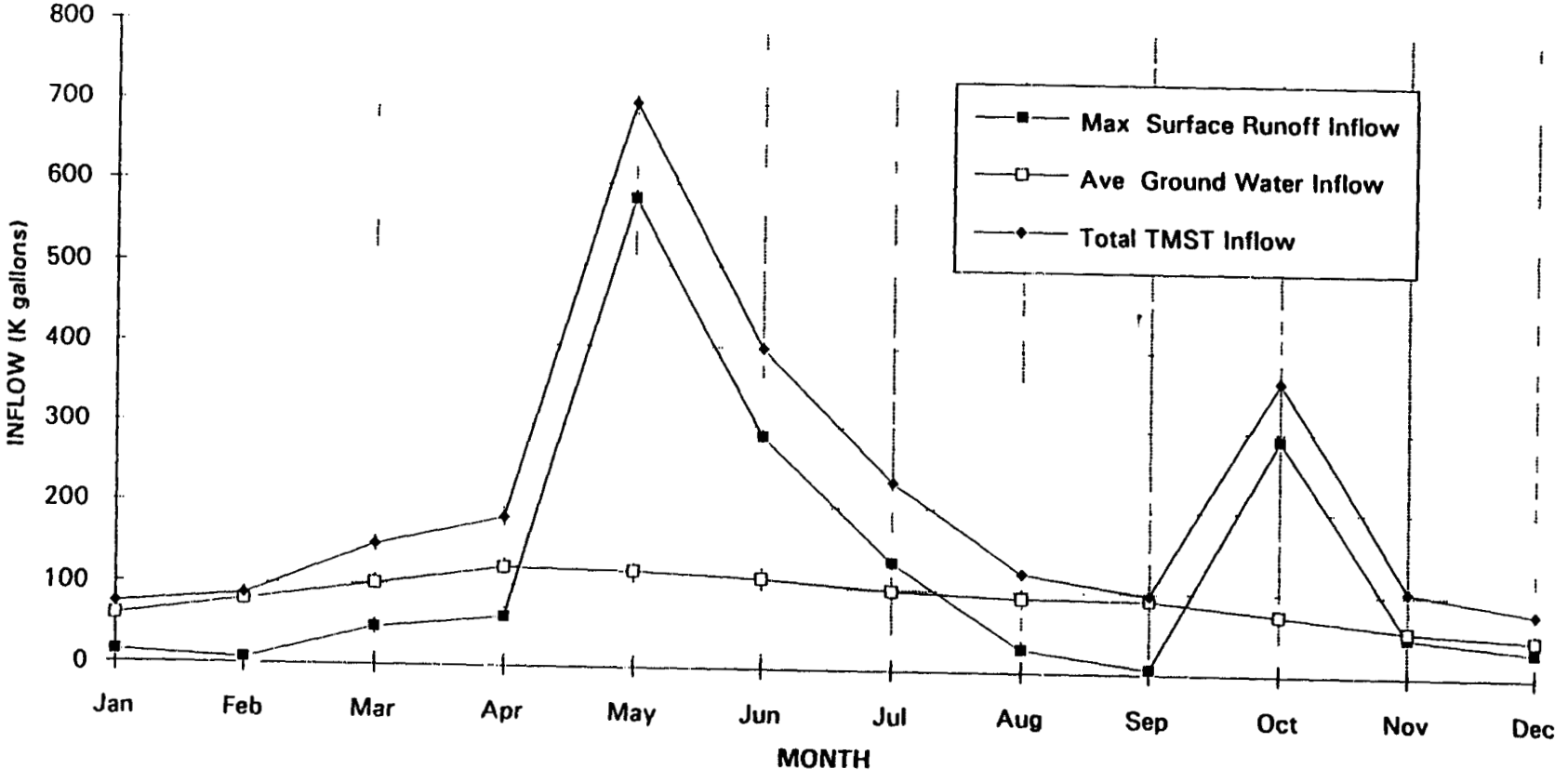


FIGURE 14 Interceptor Trench System Water Balance (4/13/93) TOTAL TMST INFLOW
MAXIMUM MONTHLY PRECIPITATION

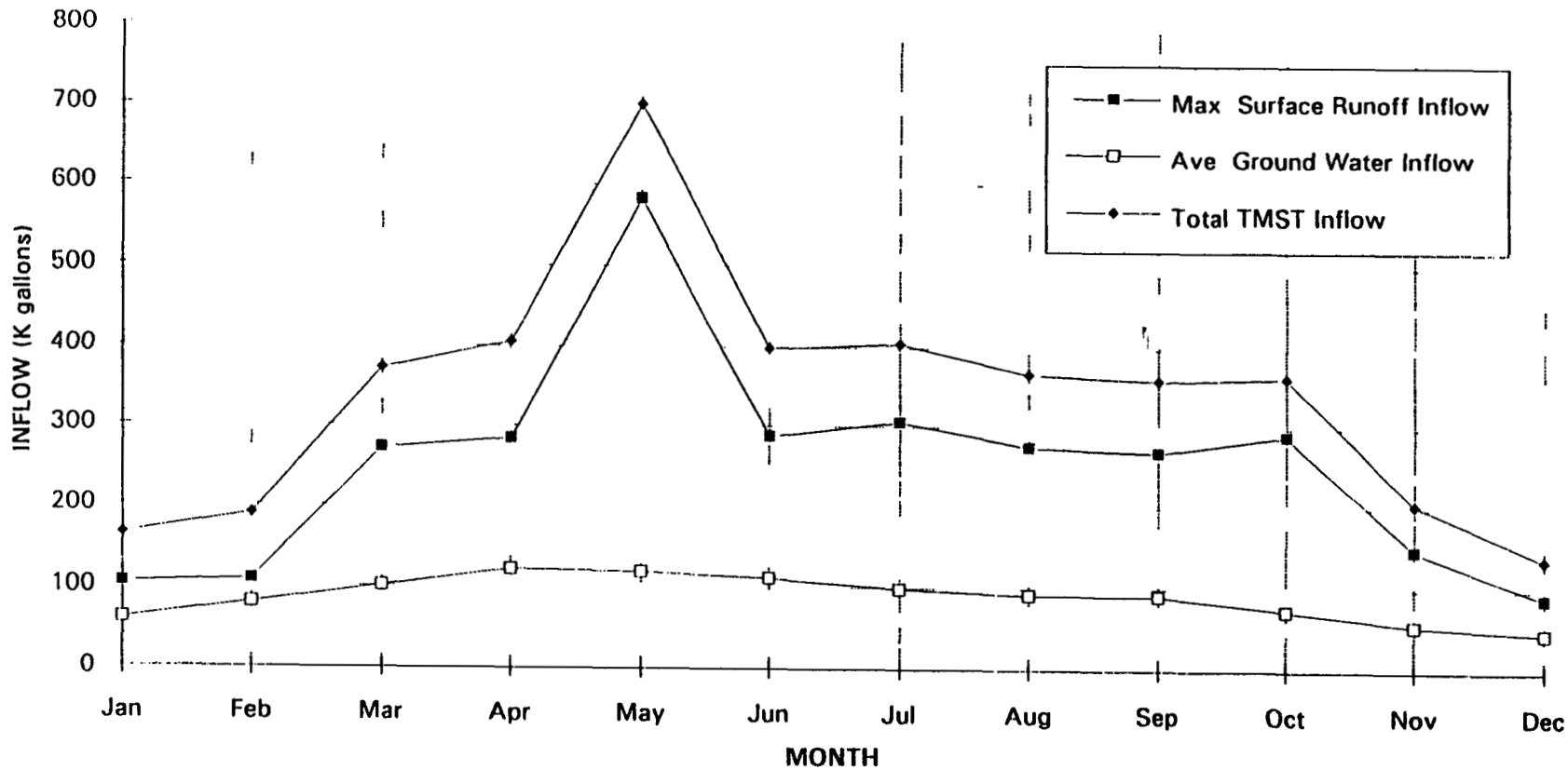


FIGURE 15 Interceptor Trench System Water Balance (4/13/93) TOTAL TMST INFLOW MEAN ANNUAL PRECIPITATION

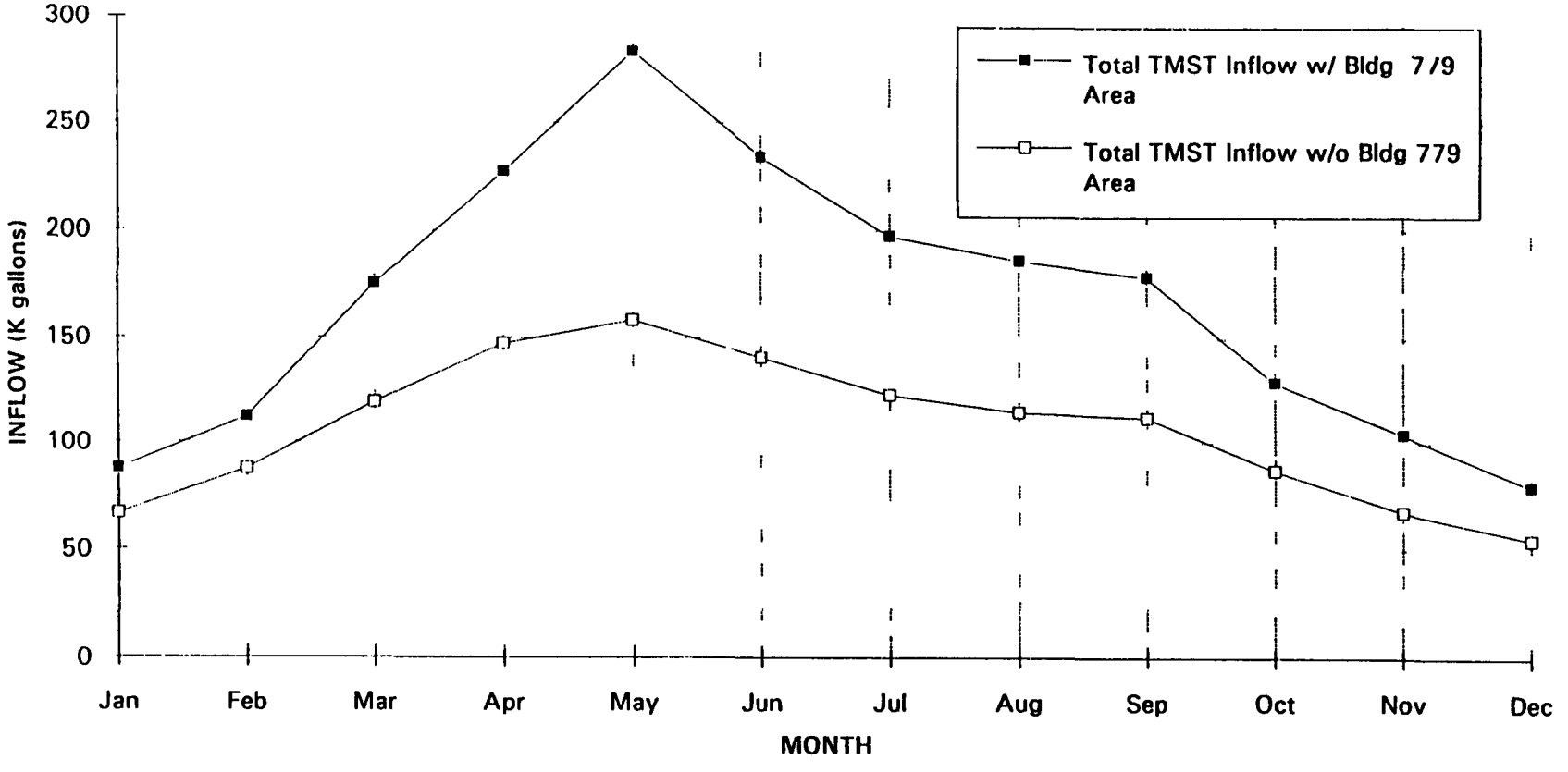


FIGURE 16 Interceptor Trench System Water Balance (4/13/93) TOTAL TMST INFLOW
MAXIMUM ANNUAL PRECIPITATION

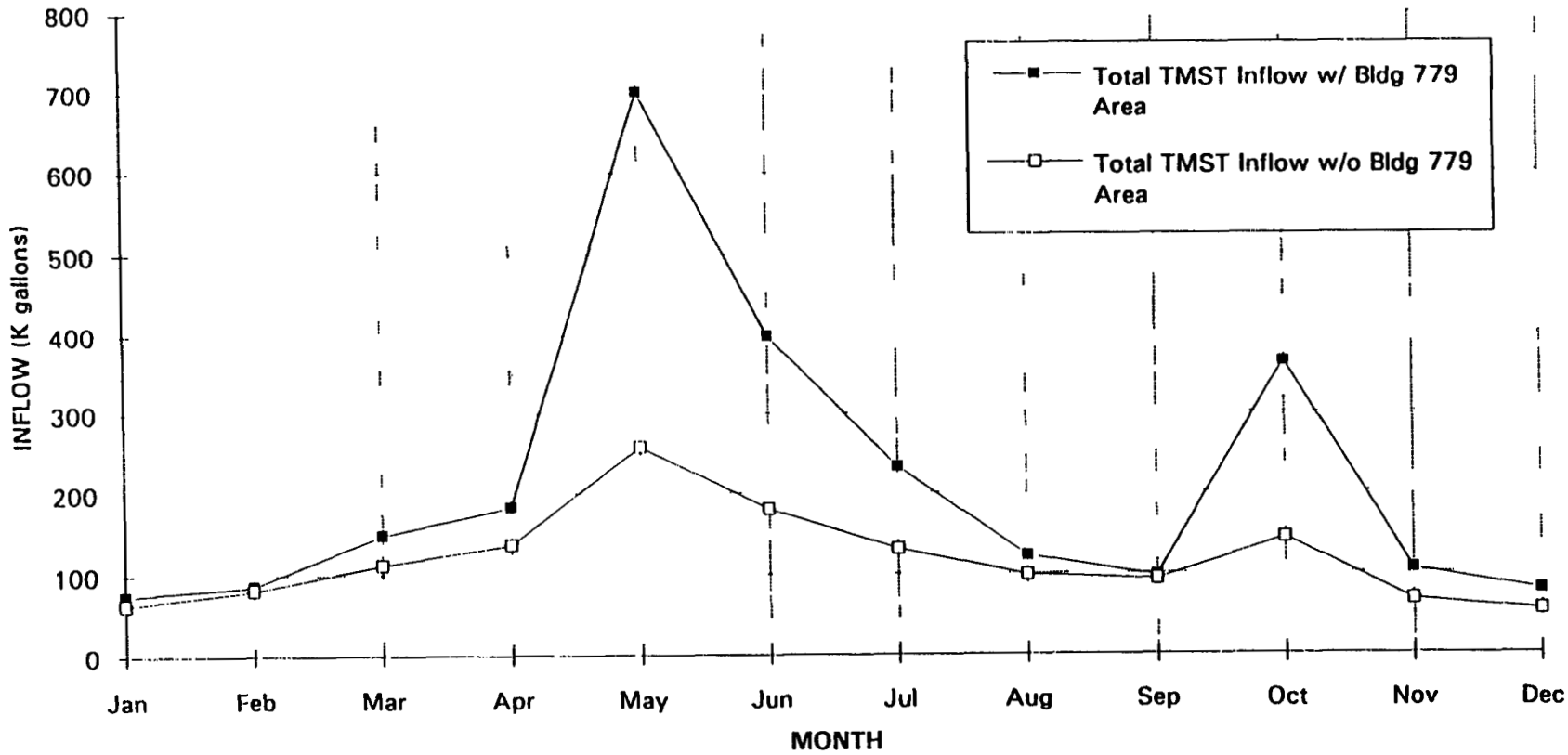


FIGURE 17 Interceptor Trench System Water Balance (4/13/93) TOTAL TMST INFLOW MAXIMUM MONTHLY PRECIPITATION

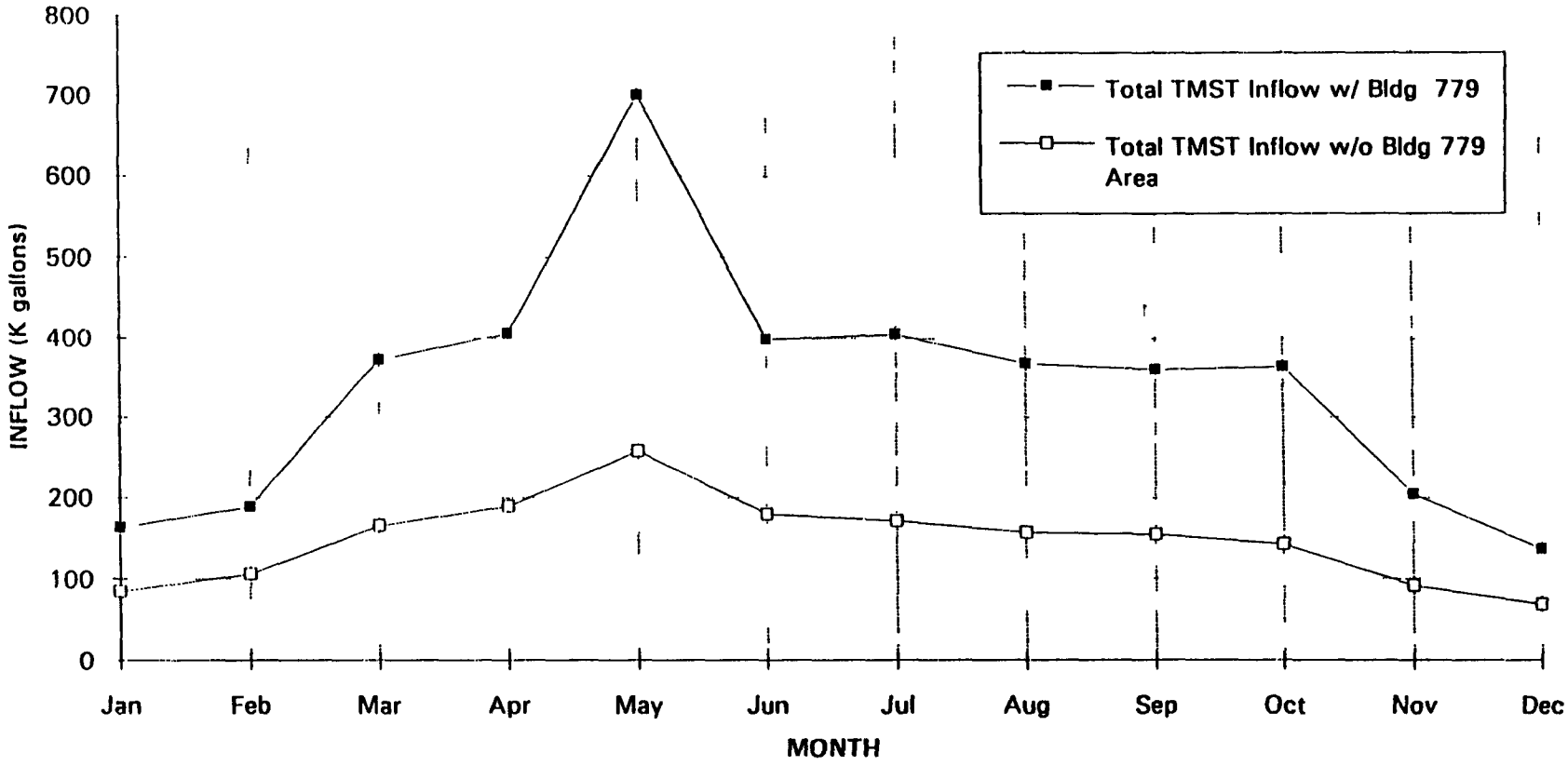


TABLE 4 Interceptor Trench System Water Balance (4/13/93)

MAXIMUM TMST INFLOW BASED ON MEAN ANNUAL PRECIPITATION

	Mean Monthly Precip (inches)	Maximum Surface Runoff Inflow to TMST (K gallons) With Bldg 779	Maximum Surface Runoff Inflow to TMST (K gallons) Without Bldg 779	Average Ground Water Inflow to TMST (K gallons)	Total Inflow to TMST (K gallons) With Bldg 779	Total Inflow to TMST (K gallons) Without Bldg 779
Jan	0 46	28	7	60	88	67
Feb	0 53	32	8	80	112	88
Mar	1 24	74	18	101	175	119
Apr	1 75	105	25	122	227	147
May	2 74	164	39	119	283	158
Jun	2 05	123	29	111	234	140
Jul	1 64	98	24	99	197	123
Aug	1 57	94	23	92	186	115
Sep	1 46	88	21	91	179	112
Oct	0 91	55	13	74	129	87
Nov	0 80	48	11	56	104	67
Dec	0 54	32	8	47	79	55
TOTAL	15 69	941	225	1052	1993	1277

TABLE 5 Interceptor Trench System Water Balance (4/13/93)

MAXIMUM TMST INFLOW BASED ON MAXIMUM ANNUAL PRECIPITATION

	Maximum Annual Precip (inches)	Maximum Surface Runoff Inflow to TMST (K gallons) With Bldg 779	Maximum Surface Runoff Inflow to TMST (K gallons) Without Bldg 779	Average Ground Water Inflow to TMST (K gallons)	Total Inflow to TMST (K gallons) With Bldg 779	Total Inflow to TMST (K gallons) Without Bldg 779
Jan	0 25	15	4	60	75	64
Feb	0 12	7	2	80	87	82
Mar	0 79	47	11	101	148	112
Apr	1 02	61	15	122	183	137
May	9 70	582	139	119	701	258
Jun	4 79	287	69	111	398	180
Jul	2 22	133	32	99	232	131
Aug	0 49	29	7	92	121	99
Sep	0 11	7	2	91	98	93
Oct	4 83	290	69	74	364	143
Nov	0 81	49	12	56	105	68
Dec	0 54	32	8	47	79	55
TOTAL	25 67	1540	368	1052	2592	1420

TABLE 6 Interceptor Trench System Water Balance (4/13/93)

MAXIMUM TMST INFLOW BASED ON MAXIMUM MONTHLY PRECIPITATION

	Maximum Monthly Precip (inches)	Maximum Surface Runoff Inflow to TMST (K gallons) With Bldg 779	Maximum Surface Runoff Inflow to TMST (K gallons) Without Bldg 779	Average Ground Water Inflow to TMST (K gallons)	Total Inflow to TMST (K gallons) With Bldg 779	Total Inflow to TMST (K gallons) Without Bldg 779
Jan	1 73	104	25	60	164	85
Feb	1 81	109	26	80	189	106
Mar	4 52	271	65	101	372	166
Apr	4 73	284	68	122	406	190
May	9 70	582	139	119	701	258
Jun	4 79	287	69	111	398	180
Jul	5 10	306	73	99	405	172
Aug	4 59	275	66	92	367	158
Sep	4 49	269	64	91	360	155
Oct	4 83	290	69	74	364	143
Nov	2 47	148	35	56	204	91
Dec	1 50	90	22	47	137	69
TOTAL	50 26	3016	720	1052	4068	1772

FIGURE 18 Interceptor Trench System Water Balance (4/13/93) TMST SURFACE RUNOFF INFLOW VOLUME VS TOTAL PRECIPITATION (including BLDG 779 Area)

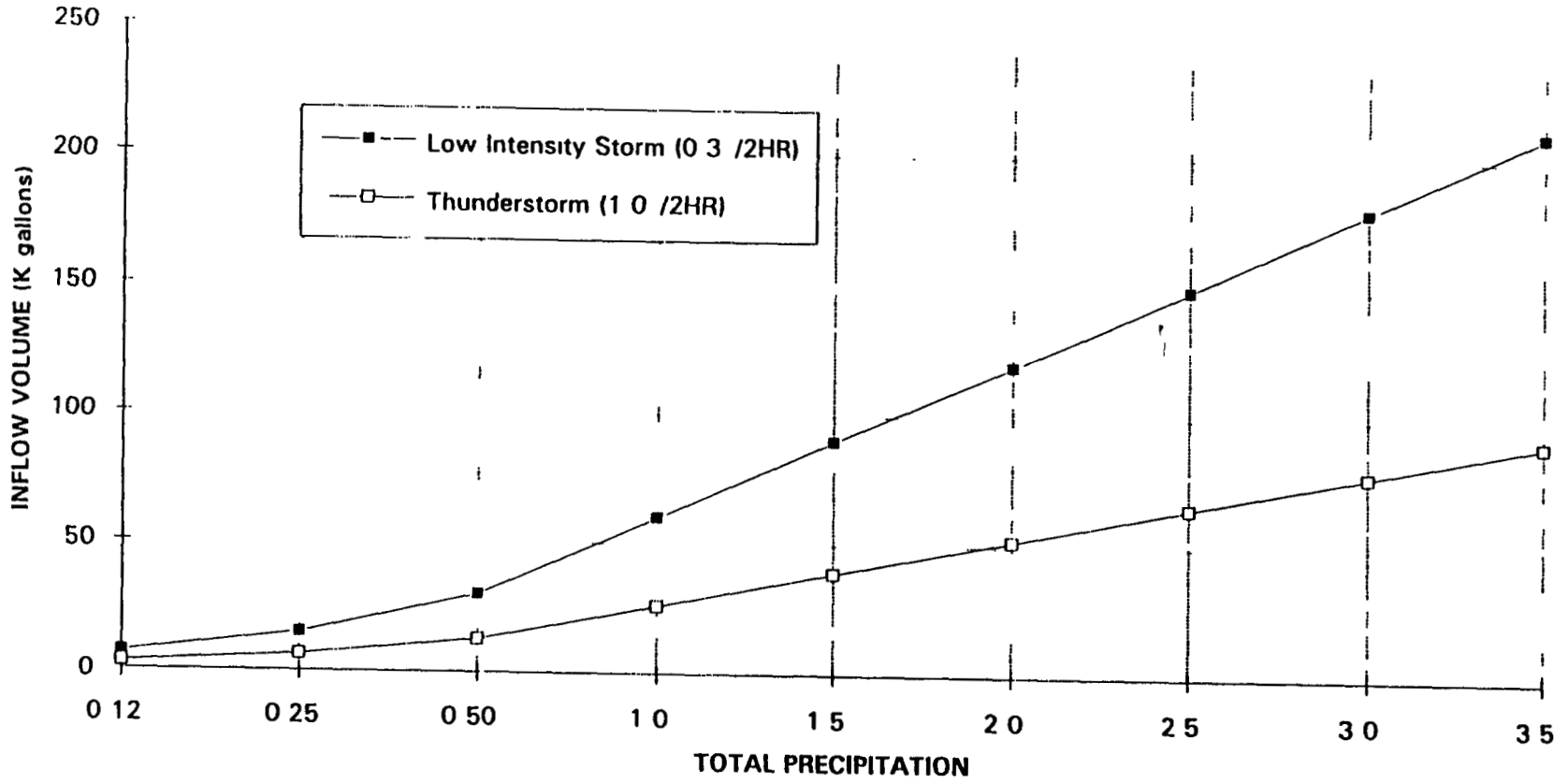
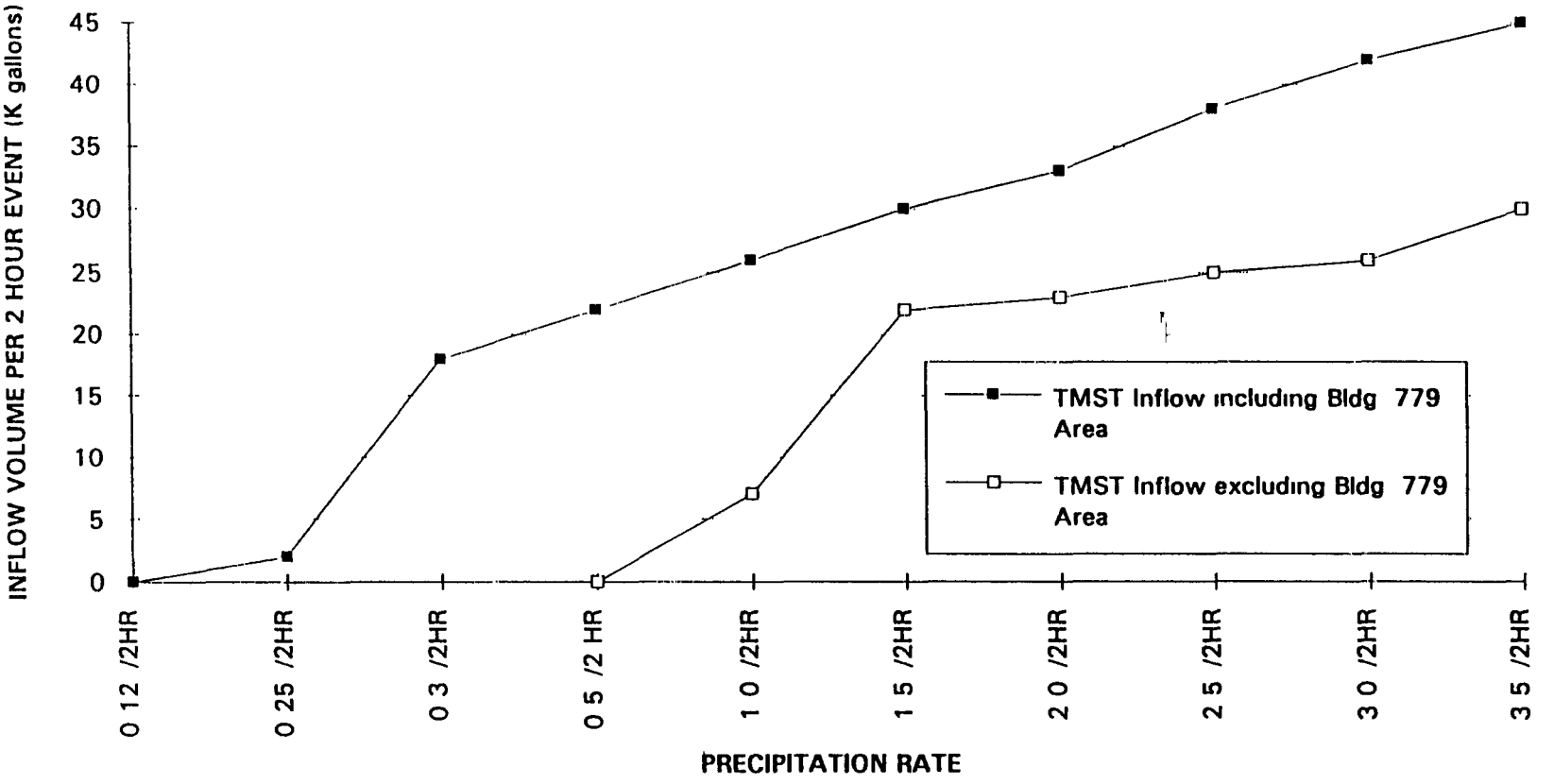


FIGURE 19 Interceptor Trench System Water Balance (4/13/93) TMST SURFACE RUNOFF INFLOW VOLUME VS PRECIPITATION RATE



Building 779 Removed From The Tributary Area

As previously stated it is unclear if the OU4 IM/IRA is intended to collect and treat the runoff from the Building 779 area The contribution of the Building 779 area is significantly increases the calculated total volume of inflow to the French drain The calculated inflows to the French drain with and without the Building 779 area are shown on Figures 15 16 and 17 and Tables 4 5 and 6 For an average precipitation year the calculated reduction of the total inflow to the TMST by removing the Building 779 area is 36% (700 000 gallons) The calculated reductions of inflow for the maximum annual and maximum monthly precipitation amounts are 45% (1 1 million gallons) and 56% (2 3 million gallons) respectively

Exclusion of the runoff from the Building 779 area could be accomplished by extending the existing 15 CMP culvert past the French drain (approximately 150) into the existing storm drain Another alternative would be to cover the French drain at the ground surface in the area of the 15 CMP outfall Either alternative could be accomplished relatively easily with little or no impact to existing drainage systems

RECOMMENDATIONS

A determination should be made regarding the validity of the inclusion of the Building 779 area surface water runoff in the OU4 IM/IRA If these flows can be excluded from the IM/IRA calculated reductions of 36% to 56% of the inflow to the TMST may be realized

The runoff and ground water flow volumes contained in this report are based on limited data and have been determined using validated models which provide reasonable estimates for design purposes These models are not a substitute for accurately collected field data The collection of accurate site specific data is also necessary to refine and calibrate the precipitation TMST inflow relationship that has been estimated in this report An example of a minimum site specific data collection system would include (1) a tipping bucket rainfall gauge (2) flow monitoring equipment on the TMST inflow and (3) flow monitoring of any ITPH overflows

REFERENCES

EG&G 1991 Task 7 Report of the Zero Offsite Water Discharge Study Solar Ponds Interceptor Trench System Groundwater Management Study EG&G Rocky Flats Inc 1991

EG&G 1992 Rocky Flats Plant Drainage and Flood Control Master Plan EG&G Rocky Flats Inc 1992